

ChemBrief



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A Brief Discussion of Rheological Profiles

Rheology is the measure of deformation of a system under shear conditions. As shear varies, the system will usually exhibit one of the four major rheology profiles: Newtonian, dilatant, pseudoplastic, or thixotropic. A system with a Newtonian rheological profile will exhibit no variation in viscosity as shear is applied or released. Honey is a fairly Newtonian material. It is thick under conditions of both high and low shear. A graphical representation of Newtonian rheology is seen in figure 1.

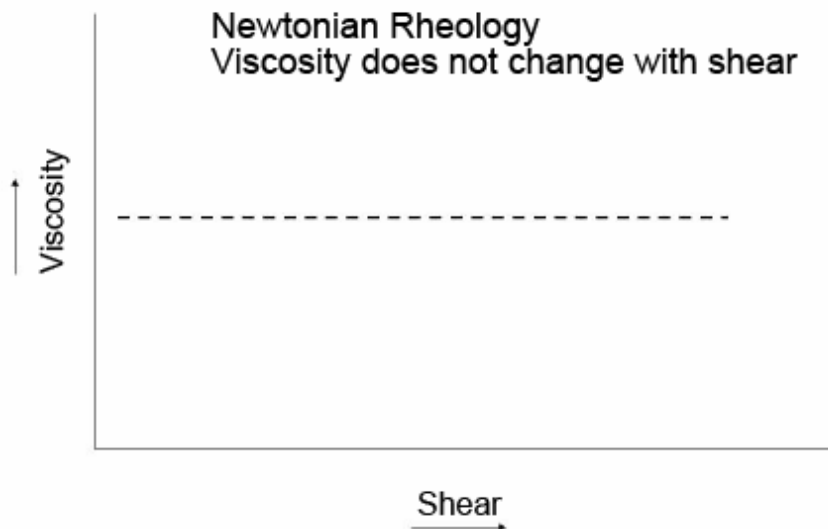


Figure 1

A dilatant material is one that is not normally encountered. Dilatant materials exhibit higher viscosity as shear is increased. Typical examples include higher solids slurries (such as calcium carbonate or kaolin slurries). These materials thicken under shear making them very difficult if not impossible to pump. This dilatancy may be mitigated or controlled with a careful selection of the quantity and quality of dispersants. Another example of a dilatant material is the

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classic quicksand in the old movies. As the victim struggled to free himself, he became hopelessly mired in the quicksand. If he simply had enough presence of mind to move very slowly, he would have extricated himself from the quicksand. A dilatant rheological profile is presented in Figure 2.

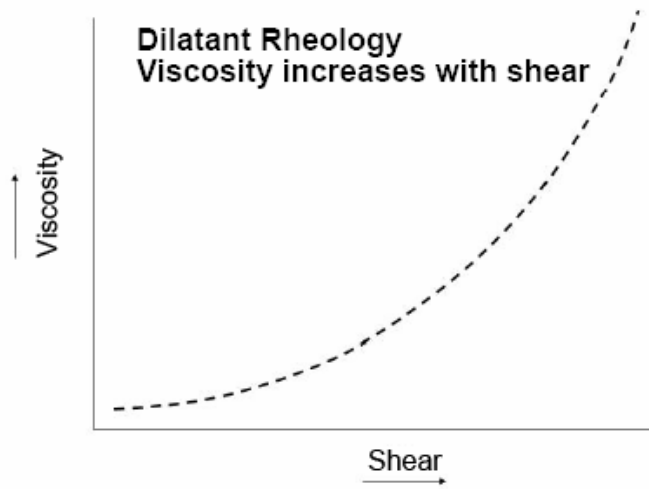


Figure 2

A pseudoplastic material displays high viscosity at low shear, low viscosity at high shear, and recovers viscosity immediately upon the release of shear. Some minerals (such as attapulgite) generate such a rheological profile. In most coatings and formulated products that have an “application cycle”, pseudoplastic rheology is less desirable than a thixotropic rheological profile because there is no time for the applied film to flow and level. A failure to allow time to flow and level will cause defects such as uneven film thickness and/or surface imperfections as a result of the application device (such as brush marks). A pseudoplastic rheological profile is represented in Figure 3 below.

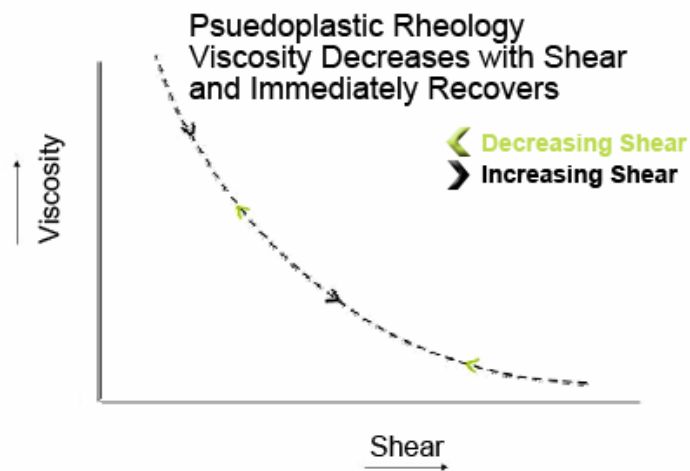


Figure 3

Finally, a thixotropic material is similar to a pseudoplastic material in one regard – it does exhibit lower viscosity as shear increases. However, the thixotropic profile differs substantially from the pseudoplastic profile in the manner in which viscosity recovers from the release of shear. Where viscosity in a pseudoplastic material recovers immediately upon the release of shear, in a thixotropic material there is a measurable delay in the recovery of viscosity. This delay allows for a period of

flow and leveling or film consolidation to occur. Such a delay also allows the graphing of a hysteresis loop in which the viscosity is plotted as a function of shear both as shear is applied and released. This allows a graph to display number of properties that are of a system’s rheology. These properties include the degree of thixotropy, the absolute viscosity values at a given shear rate, and the speed of viscosity recovery. Commonly heard terms include requests for a more or less thixotropic/Newtonian

viscosity and faster or slower recovery rates. Requests for higher or lower viscosities, particularly when



accompanied by specific values, must always be queried for the shear rate at which the viscosity is to be measured. A typical thixotropic rheological profile is seen in Figure 4.

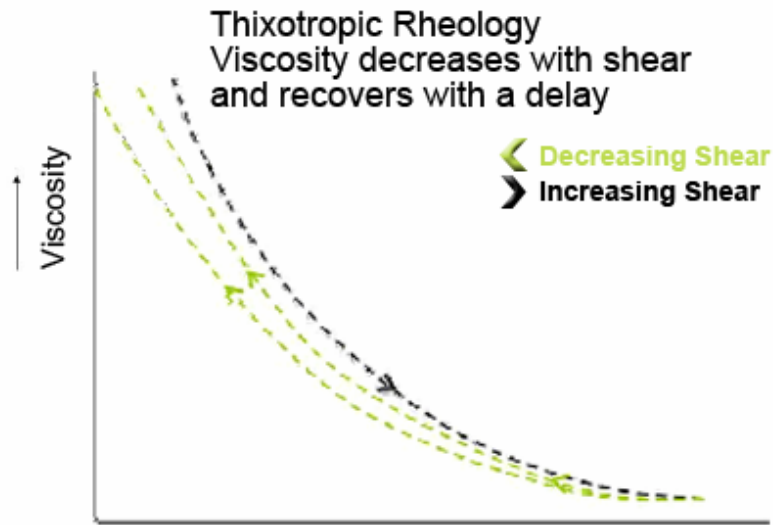


Figure 4

*For more information on how Southern Clay Products can assist you,
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